

forming a titanium nitride layer on walls of the second contact hole and on the silicide pad;

filling the contact hole with tungsten to form a tungsten plug, the tungsten plug contacting the titanium nitride layer and being connected to the polysilicon plug through the silicide pad and being aligned with the polysilicon plug; and

forming a tungsten layer on the second interlayer insulating film and contacting the tungsten plug.--

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REMARKS

Claims 1-17 are present in the application.

Claims 1, 2, 4, 5, 7 and 8 are rejected as being anticipated by SAKOH 5,641,991.

Reconsideration and withdrawal of the rejection are respectfully requested because the reference does not disclose or suggest a silicide pad formed on a top surface of a silicon contact plug in a self-aligning manner with the silicon contact plug as recited in claim 1 of the present application.

In contrast, SAKOH discloses at column 6, lines 26-32, for example, that unreacted Ti layer 11 and reaction products such as TiN are removed, resulting in a patterned silicide layer 12 formed on remaining polysilicon layer 4. Thus, the silicide layer 12 is selectively formed in self-alignment with the polysilicon layer 4, not a silicon contact plug. As the reference clearly does not disclose that which is recited, the

anticipation rejection is not viable. Accordingly, reconsideration and allowance of claim 1 are respectfully requested.

Claims 2-6 depend from claim 1 and further define the invention and are also believed patentable over SAKOH.

Claim 7 also includes the feature of the silicide pad formed in a self-aligning manner with the silicon contact plug. The comments above regarding claim 1 are equally applicable to claim 7. Claim 8 depends from claim 7 and further defines the invention and is also believed patentable over the cited prior art.

Claims 3 and 6 are rejected as being unpatentable over SAKOH in view of IWATA et al. 6,291,861. This rejection is respectfully traversed.

IWATA et al. is cited for the teaching of cobalt as a refractory metal. IWATA et al. do not disclose or suggest a silicide pad formed on the top surface of a silicon contact plug in a self-aligning manner with the silicon contact plug as recited in claim 1 of the present application. As noted above, SAKOH does not disclose or suggest what is recited in claim 1. Since claims 3 and 6 depend from claim 1 and further define the invention, the combination of references would not render obvious claims 3 and 6.

Claims 9 and 15 are rejected as unpatentable over SAKOH in view of WIECZOREK et al. 6,271,122 and in view of further remarks. This rejection is respectfully traversed.

WIECZOREK et al. is cited for the teaching of molybdenum, tantalum and cobalt silicides. WIECZOREK et al. do not disclose or suggest a silicide pad formed in a self-aligning manner with a polysilicon contact plug as recited in claim 7. As noted above, SAKOH does not disclose or suggest what is recited in claim 7. Since claim 9 depends from claim 7 and further defines the invention, for the reasons set forth above regarding claim 7, claim 9 is also believed patentable over the cited prior art.

Claim 15 depends from claim 13 and further defines the invention. Claim 13 recites forming a silicide pad on a polysilicon plug in a self-aligning manner with the polysilicon plug. As noted above, this feature is missing from each of the references, is absent from the combination and thus is not obvious to one having ordinary skill in the art. Accordingly, the combination of references would not render obvious claim 15.

Claim 10 is rejected as being unpatentable over SAKOH in view of WU et al. 5,998,251, WIECZOREK et al. and in view of further remarks. This rejection is respectfully traversed.

WU et al. is cited for the teaching of a tungsten conductive plug, a second interlayer insulating film and an aluminum copper layer as a conductive layer. WU et al. do not

disclose or suggest a silicide pad formed in a self-aligning manner with a polysilicon contact plug as recited in claim 7. As noted above, SAKOH in view of WIECZOREK et al. in view of further remarks does not disclose or suggest what is recited in claim 7. Since claim 10 depends from claim 7 and further defines the invention, the combination of references would not render obvious claim 10.

Claims 11 and 12 are rejected as unpatentable over SAKOH in view of HUANG 6,096,595. This rejection is respectfully traversed.

HUANG is cited for the teaching of a second insulating layer on top of a first insulating layer. HUANG does not disclose or suggest a silicide pad formed on a first surface of a polysilicon contact plug in a self-aligning manner with the polysilicon contact plug. As noted above regarding claim 1, SAKOH does not disclose or suggest this feature. This feature is missing from each of the references, is absent from the combination and thus is not obvious to one having ordinary skill in the art.

Claim 12 depends from claim 11 and further defines the invention. For the reasons set forth above regarding claim 11, claim 12 is also believed patentable over the cited prior art.

Claims 13 and 14 are rejected as being unpatentable over SAKOH in view of further remarks. This rejection is respectfully traversed.

The Official Action states that it is considered routine skill in the art to dope a polysilicon plug. However, SAKOH does not disclose or suggest, nor is it considered routine skill in the art to form a silicide pad on a polysilicon plug in a self-aligning manner with the polysilicon plug as also recited in claim 13. Accordingly, claim 13 is believed patentable over the cited prior art. Claim 14 depends from claim 13 and further defines the invention and is also believed patentable over the cited prior art.

Claims 16 and 17 are rejected as unpatentable over SAKOH in view of WU et al., WIECZOREK et al. in view of further remarks. This rejection is respectfully traversed.

The Official Action states that SAKOH discloses the recited invention except for explicitly teaching the formation of a second insulating layer and using a tungsten plug and tungsten connecting layer. However, as noted above, SAKOH does not disclose or suggest the feature of forming a silicide pad on a polysilicon plug in a self-aligning manner with the polysilicon plug as recited in claim 13. As also noted above, this feature is missing from each of the references, is absent from the combination and thus is not obvious to one having ordinary skill in the art. Claim 16 depends from claim 13 and further defines the invention and is also believed patentable over the cited prior art. Claim 17 also recites this feature. The comments above regarding claim 16 are equally applicable to claim 17.

In addition, claims 5 and 14 recite the step of selectively and partially removing the first insulating film at least in the vicinity of the contact plug such that the plug protrudes. By way of example, Figure 2C and page 11, lines 15-18, of the present application disclose an etch-back process where the interlayer insulating film 15 is etched so that polysilicon plug 17 protrudes from the interlayer insulating film 15.

In contrast, Figures 2B and 2C of SAKOH, for example, show that the polysilicon plug 8 is formed above the interlayer insulator and then is etched back and still remains above the interlayer insulator. SAKOH does not disclose or suggest selectively and partially removing the first interlayer insulating film such that the plug protrudes as recited in claims 5 and 14 of the present application. Accordingly, claims 5 and 14 are believed patentable regardless of the patentability of the claims from which they depend.

In view of the present amendment and the foregoing remarks, it is believed that the present application has been placed in condition for allowance. Reconsideration and allowance are respectfully requested.

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Attached hereto is a marked-up version showing the changes made to the claims. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

Respectfully submitted,

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**"VERSION WITH MARKINGS TO SHOW CHANGES MADE"**

IN THE CLAIMS:

Claim 1 has been amended as follows:

--1. (amended) A structure for a semiconductor device, provided with a contact plug, which is formed by forming a contact hole through a first interlayer insulating film on a silicon substrate and by filling the contact hole with silicon, comprising:

a silicide pad formed on the top surface of the silicon contact plug in a self-aligning manner with said silicon contact plug and having a diameter which is larger than that of the silicon contact plug;

wherein, the top surface of said silicide pad is formed above the top surface of said first interlayer insulating film.--

Claim 4 has been amended as follows:

--4. (amended) A method for manufacturing a semiconductor device, provided with a contact plug, which is formed by opening a contact hole through a first interlayer insulating film formed on a silicon substrate and filling the contact hole with silicon, comprising the steps of:

forming a first insulating film on said silicon substrate;

forming said contact hole through said first interlayer insulating film;

filling said contact hole with a silicon plug; and



forming a silicide pad in a self-aligning manner with the silicon plug, the silicide pad having a larger diameter than that of said silicon plug [in a self-aligning manner].--

Claim 7 has been amended as follows:

--7. (amended) A structure of a semiconductor device, comprising:

a silicon substrate;

a first interlayer insulating film having a first surface connected to said substrate;

a polysilicon contact plug formed through said first interlayer insulating film having a top end surface and a top side surface protruding from a second surface of said first insulating layer;

a silicide pad formed covering said top end surface and said top side surface of said polysilicon contact plug in a self-aligning manner with said polysilicon contact plug and said silicide pad having a diameter which is larger than a diameter of the polysilicon contact plug, said silicide pad being above said second surface of said first interlayer insulating film.--

Claim 10 has been amended as follows:

--10. (amended) The structure of a semiconductor device according to claim 7, further comprising:

a second interlayer insulating film on the second surface of said first interlayer insulating film and on said silicide pad;

a tungsten plug through said second interlayer insulating film and aligned with [a center of] the polysilicon contact plug, said tungsten plug contacting said silicide pad; and

an aluminum copper alloy connected to said second interlayer insulating film and said tungsten plug.--

Claim 11 has been amended as follows:

--11. (amended) A structure of a semiconductor device, comprising:

a silicon substrate;

a first interlayer insulating film having a first surface on the substrate;

a polysilicon contact plug through said first interlayer insulating film;

a silicide pad formed on a first surface of said polysilicon contact plug in a self-aligning manner with said polysilicon contact plug and having a diameter which is larger than the polysilicon contact plug, a first surface of said silicide pad being above a second surface of said interlayer insulating film; and

a second interlayer insulating film on said first interlayer insulating film on said silicide pad.--

Claim 12 has been amended as follows:

--12. (amended) A structure of a semiconductor device according to claim 11, further comprising:

an upper plug on the polysilicon plug and through said second interlayer insulating film and aligned with [a center of] the polysilicon contact plug;

and a conductive film connected to said second interlayer insulating film and said upper plug.--

Claim 13 has been amended as follows:

--13. (amended) A method for manufacturing a semiconductor device, comprising the steps of:

forming a silicon substrate;

forming a first interlayer insulating film above the silicon substrate;

forming a first contact hole through the first interlayer insulating film;

forming a polysilicon layer on the first interlayer insulating film, the polysilicon layer filling the contact hole and forming a polysilicon plug;

[doping the polysilicon plug with an impurity having an impurity concentration of between  $1 \times 10^{20}$  and  $1.5 \times 10^{20} \text{ cm}^{-3}$ ;]  
and

forming a silicide pad [in a self-aligning manner] on the polysilicon plug in a self-aligning manner with the polysilicon plug, the silicide pad having a diameter larger than

a diameter of the polysilicon plug, a first surface of the silicide pad being disposed above an upper surface of the first interlayer insulating film.--

Claim 16 has been amended as follows:

--16. (amended) The method for manufacturing a semiconductor device according to claim 13, further comprising the steps of:

forming a second interlayer insulating film on the first interlayer insulating film and on the silicide pad;

forming a second contact hole through the second interlayer insulating film, the second contact hole extending to the silicide pad;

forming a titanium nitride layer on walls of the second contact hole and on the silicide pad;

filling the contact hole with tungsten to form a tungsten plug, the tungsten plug contacting the titanium nitride layer and being connected to the polysilicon plug through the silicide pad and being aligned with [a center of] the polysilicon plug; and

forming a tungsten layer on the second interlayer insulating film and contacting the tungsten plug.--

Claim 17 has been amended as follows:

--17. (amended) A method for manufacturing a semiconductor device, comprising the steps of:

forming a silicon substrate;

forming a first interlayer insulating film above the silicon substrate;

forming a first contact hole [though] through the first interlayer insulating film;

forming a polysilicon layer on the first interlayer insulating film, the polysilicon layer filling the contact hole and forming a polysilicon plug;

forming a silicide pad in a self-aligning manner [on] with the polysilicon plug, the silicide pad having a diameter larger than a diameter of the polysilicon plug, a first surface of the silicide pad being disposed above an upper surface of the first interlayer insulating film

forming a second interlayer insulating film on the first interlayer insulating film and on the silicide pad;

forming a second contact hole through the second interlayer insulating film, the second contact hole extending to the silicide pad;

forming a titanium nitride layer on walls of the second contact hole and on the silicide pad;

filling the contact hole with tungsten to form a tungsten plug, the tungsten plug contacting the titanium nitride layer and being connected to the polysilicon plug through the silicide pad and being aligned with [a center of] the polysilicon plug; and

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forming a tungsten layer on the second interlayer  
insulating film and contacting the tungsten plug.--